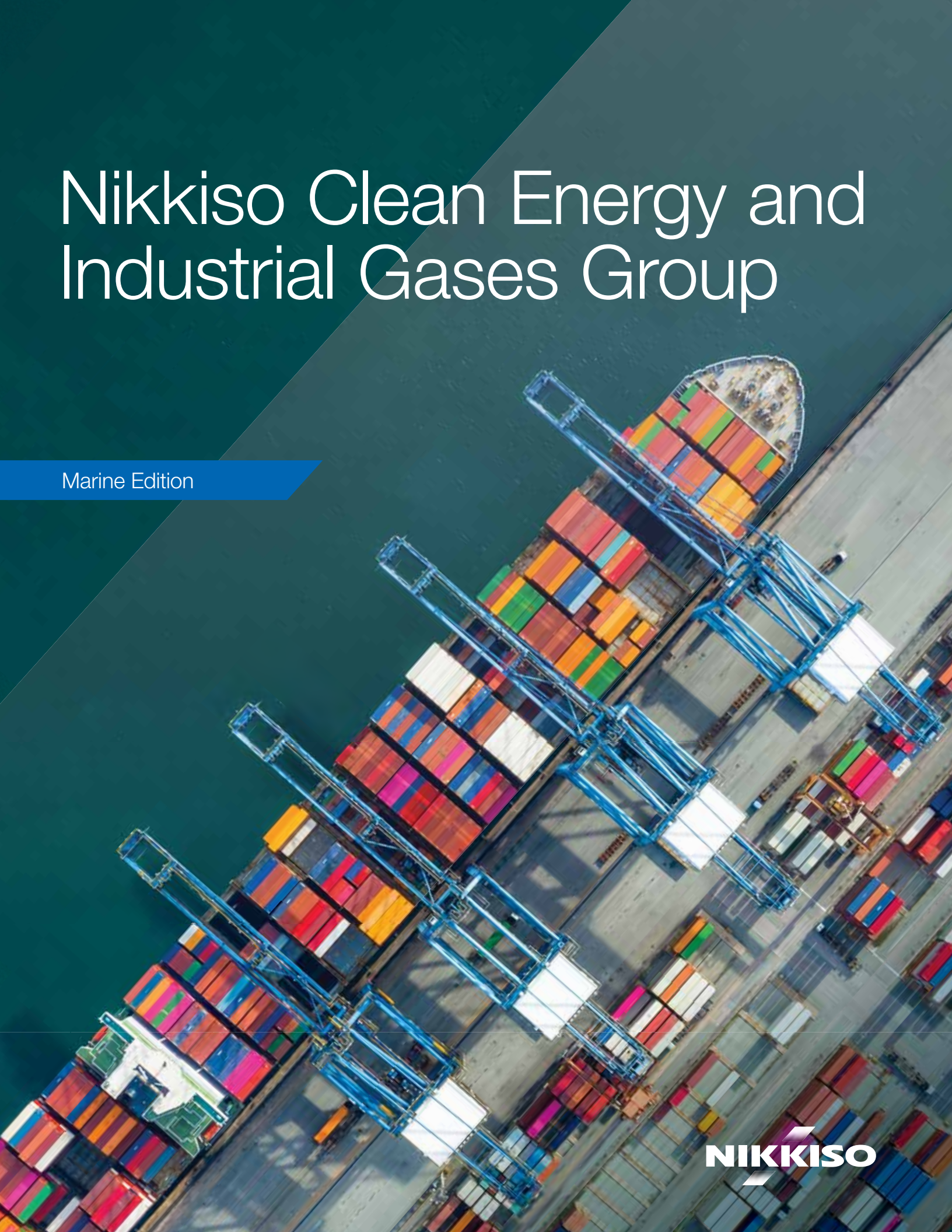
Nikkiso Clean Energy and Industrial Gases Group

Marine Edition



NIKKISO

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Marine Edition

Nikkiso Cryogenic Industries
Clean Energy and Industrial Gases Group

Nikkiso Cryogenic Industries Clean Energy and Industrial Gases Group was created from the March 2019 consolidation of Cryogenic Industries and Nikkiso Cryo, both a part of Nikkiso Co., Ltd. Japan. Working together with our shared experience, resources and commitment to quality allows us to focus more closely on our customers' needs, providing individual support, service and solutions.

Vision

Leading the change to a healthier world

Mission

We provide innovative equipment, technologies and services through our global group of companies to help our customers to make a difference

The group consists of five functional units:

Cryogenic Pumps – Aligns Nikkiso ACD's and Nikkiso Cryo's lines of pumps

Cryogenic Process Systems – Provides cryogenic plants including LNG and Air Separation plants

Heat Exchanger Systems – Focuses on cryogenic vaporizers, LNG and industrial gas equipment

Cryogenic Services – Provides service and support through a network of 20 global facilities

Integrated Cryogenic Solutions – Newly created, they provide for centralized management of product and project development across channels and in multiple market segments.

"One key benefit of our new business approach is the capacity to expand our offerings and provide a comprehensive product line for clean energy such as LNG and hydrogen, in addition to our existing line of products for industrial gases," said Peter Wagner, President and CEO of Cryogenic Industries.

Through joint research and innovation, the Group provides increased engineering and systems solutions for market development.

Our Story

For well over 50 years, we have been engineering, manufacturing and servicing cryogenic products for the Marine industry.

All major components of our Marine Gas Systems are designed and built by us—that's how we are able to provide the broadest flow rate, highest efficiency and lowest NPSH on the market while offering a low-cost to you. We have LNG powered fuel gas systems installed on nearly 400 vessels, and back up those systems with manufacturing approval certificates from ABS, BV, DNV, LR and ClassNK. Add to all this the largest global network of aftermarket service centers and that means port-to-port maintenance solutions and peace of mind for you.

Over the course of their lifetime, Nikkiso submerged pumps can bunker over a billion gallons of liquid. The same state-of-the-art design that bunkers your ship, can also power your ship, or provide LNG fuel over tremendous distances to remote power plants. With our modular and scalable design we can meet your specific requirements for any combination of flow and pressure. Our high efficiency, extremely low NPSHR inducer maximizes fluid utilization and our ZEN (Zero Enabled NPSH) inducer was specially designed to reduce liquid to extremely low levels.

What does the future hold? Nikkiso CE&IG has experience with marine for LNG and other hydrocarbons, and we continue to expand to meet the needs for the next generation future fuels like Hydrogen, Methanol and Ammonia.

Certifications

All our parts and projects received independent certifications. Third party companies are enlisted to certify specific projects, and each project is certified independently. Spare parts or replacement parts for pumps also require individual certifications. We work directly with these agencies to ensure the scope of supply meets the marine requirements for each individual job.

Safety Standards

Committed to setting standards for safety and excellence as one of the world's leading ship classification organizations, the American Bureau of Shipping (ABS) establishes the best solutions for the industries we serve, and is at the forefront of marine and offshore innovation.

LR is a leading international provider of classification, compliance and consultancy services to the marine and offshore industries, helping our clients design, construct and operate their assets to the highest levels of safety and performance.

Bureau Veritas develops rules, rule notes and guidance notes to benefit our clients, partners, and the marine industry overall. We use the vast experience of our engineers, gained through years of service in the marine industry, combined with advanced research into structure and hydrodynamics, to ensure development of the most relevant and up-to-date rules.

IECEx and ATEX equipment certification from SGS – meet legal requirements for products used in explosive atmospheres.

DNV GL is the world's leading classification society and a recognized advisor for the Maritime industry. We enhance safety, quality, energy efficiency and environmental performance of the global shipping industry—across all vessel types and offshore structures.

Over a million companies benefit from a quality management system certified according to ISO 9001, enjoying peak process performance and an international competitive advantage. ISO 9001 certification ensures that quality orientation is lived by each of your employees every day.

NSAI

Certificate of Registration
of Quality Management System
to ISO 9001:2015

The National Standards Authority of Ireland Inc. certifies that:

Nikkiso Cryo Incorporated
4661 Eaker Street
North Las Vegas, NV 89081
USA

Central Function, Design, Testing, Assembly, Shipping and Service

Nikkiso Cryo Incorporated
4545 Lamb Blvd.
Las Vegas, NV 89115
USA

Administration and Sales

has been assessed and deemed to comply with the requirements of the above standard in respect of the scope of operations given below:

Design, Manufacture and Testing of Cryogenic pumps for the Energy Sector. Primary LNG and LPG pumps for both commercial and off-shore terminals, to include marine shipping.

All locations covered under this multi-site certification are listed above.

Geraldine Larkin
Chief Executive Officer

Lisa Greenleaf
Operations Manager

Registration Number: 19.4933 & 19.4933/A
Certification Granted: March 06, 2015
Effective Date: June 25, 2021
Expiry Date: March 23, 2023

National Standards Authority of Ireland Inc., 20 Trafalgar Square, Nashua, New Hampshire, NH 03063, USA T +1 603 882 4412

9001:2015-MSP-ANAB-US (2.0)
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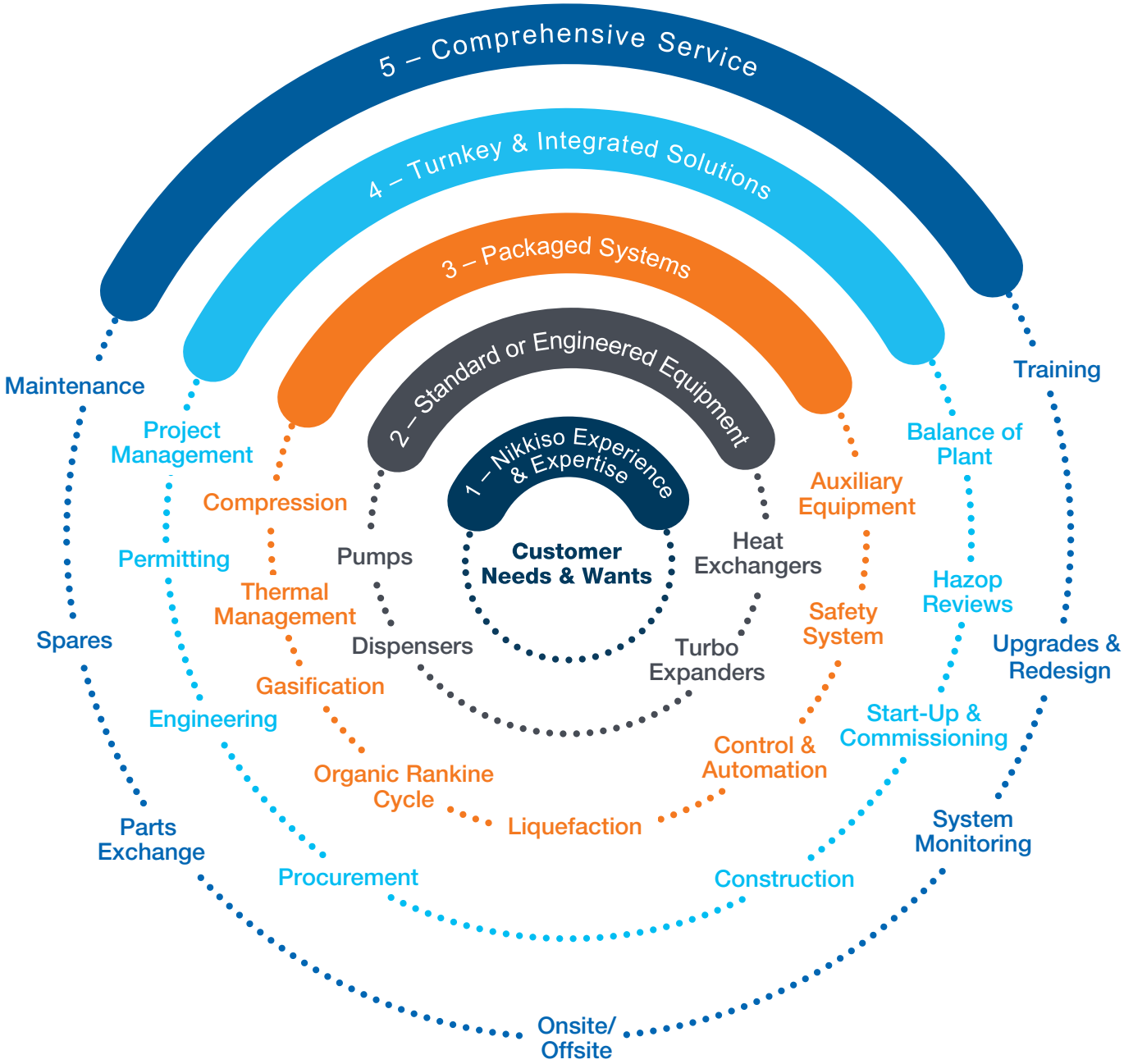
Certified to ISO 9001

Our internal corrective action system helps assure that any lessons learned are immediately corrected not only for the current project, but in all of our internal systems to ensure all future processes and designs are as trouble-free as possible. We believe that quality is a continuous process that requires us to never stop trying to improve.

Radar Map

Overview

This Marine brochure is organized according to the Radar Map below. As always, our customer's needs and wants are the core of our business. We strive to meet those needs through manufacturing, supplying standard and engineered equipment, packaged systems, turnkey and integrated solutions and offering comprehensive and global service.



Nikkiso Clean Energy & Industrial Gases Global Presence

CE&IG Group Agents:

1. Clifton, NJ, USA
2. Monterrey, Mexico
3. Buenos Aires, Argentina
4. Bilbao, Spain
5. Gonfreville-l'Orcher, France
6. Amsterdam, Netherlands
7. Milan, Italy
8. Borovichi, Russia
9. Piraeus, Greece
10. Dammam, Saudi Arabia
11. Doha, Qatar
12. Abu Dabi, UAE
13. Maroeladal, South Africa
14. Mumbai, India
15. Chengdu, China
16. Beijing, China
17. Busan/Suwon, South Korea
18. Hangzhou, China
19. Shanghai, China
20. Shenzhen, China
21. Hong Kong, China
22. Manila, Philippines
23. Ho Chi Min City, Vietnam
24. Bangkok, Thailand
25. Kuala Lumpur, Malaysia
26. Singapore, Singapore
27. Jakarta, Indonesia
28. Melbourne, Australia

Capabilities

Cargo, Container, and Tanker Vessels

- High pressure fuel gas systems for high pressure engines (LNG & LEG)
- Low pressure fuel gas pumps for feeding high pressure fuel gas systems
- Low pressure fuel gas pumps for low pressure engines (LNG & LEG)
- High pressure & low pressure vaporizer systems
- BOG recondenser systems
- Long Term Fixed Price Service Agreements

Liquid Hydrocarbon Carriers (LNG, LEG, LPG, etc.)

- Main cargo offloading pumps
- Stripping & spray pumps
- Emergency pumps
- BOG reliquefier systems
- High pressure fuel gas systems for high pressure engines (LNG & LEG)
- Low pressure fuel gas pumps for feeding high pressure fuel gas systems
- Low pressure fuel gas pumps for low pressure engines (LNG & LEG)
- High pressure & low pressure vaporizer systems

Products

Pumps – Nikkiso ACD

Model MSP 34.2

State-of-the-Art Submerged Motor Pumps

Suction Pot Mounted Installation

Specifications

Flow Range	gpm	1 – 1,600
	lpm	4 – 6,056
	LH_2 kg/hr	15 – 25,000
NPSHR	feet	0.5 – 5
	meter	0.15 – 1.5
Differential Head	feet	50 – 4,000
	meter	15 – 1,220
Pump Design Rating	hp	3.35 – 335
	kw	2.5 – 250
Speed Range	rpm	2,000 – 10,000

Consult Nikkiso ACD engineering for actual performance ratings.

Features & Benefits

- Active thrust balancing system for extended bearing life
- High-efficiency hydraulics with extremely low NPSHR inducer
- Lightweight and compact
- Available in sump and in-tank designs
- Special design VFD drive provides operation point control over the entire pump operating range
- Features a quick electrical disconnect for ease of maintenance
- All parts from wrought aluminum are precision machined
- Vacuum jacketed sump
- Heavy-duty ceramic bearings

Applications

- Fuel supply systems for rail locomotives
- Low-pressure marine fuel systems
- HP booster pump
- Liquid storage transfer
- Bunkering operations
- Peak-shaving
- Trailer loading and off-loading
- High-pressure pipeline injection
- Power generation

Complete Pumping System

- High-efficiency submerged pump
- Vacuum jacketed sump
- Custom made VFD drive – factory string tested
- Dual electrical feed thru hermetically sealed up to 500A

Optional Accessories

- Differential pressure gauge
- Loss of prime detector (cavitation protection)
- Safety relief valve
- Dual conduit box per NFPA standards for LNG services
- Complete removal systems
- Long term storage container

Products

Pumps – Nikkiso ACD

Model MSP 34

Submerged Motor Pumps

1 x 2 x 6 - 2S/4S and
1.5 x 2.5 x 6 - 2S
Not suitable for Oxygen service

Specifications

Pump Size	units	1 x 2 x 6 - 2S
Flow Range	gpm	2 – 120
	lpm	8 – 450
NPSHR	feet	1.5 – 12
	meter	0.5 – 4
Differential Head	feet	50 – 1,200
	meter	15 – 365
Pump Design Rating	hp	10 up to 44
	kw	7.5 up to 33
Speed Range	rpm	1,500 – 7,200

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- Gastight design
- Pump and motor are fully submerged in liquid minimizing loss and guaranteeing quick response pumping
- Vacuum jacketed sump provides extremely low heat leak — ideal pumping conditions (optional)
- Sealless and submerged design minimizes maintenance requirements
- Vertical pump design provides greater stability and longer life
- Special design VFD motor provides broad range of operation

Applications

Use where product loss is not acceptable

- Liquid storage transfer
- Mobile delivery transfer – LAR, LN_2
- Vehicle fueling stations – LNG

Liquids Pumped

- Nitrogen
- Argon
- Ethylene
- Ethane
- Methane
- Propane
- Hydrogen

Optional Accessories

- Vacuum jacketed sump
- Variable frequency drive
- Differential pressure gauge
- Loss of prime detector (cavitation protection)
- Safety relief valve
- Dual conduit box per NFPA standards for LNG service

Products

Pumps – Nikkiso ACD

Model MSP-SL

High Flow/High Pressure Pumps for Marine Applications

Specifications

Flow Rate	1 – 31 m^3/h
Pressure	200 – 414 bar
Suction Pressure Req'd	4 bar (above saturation pressure)
Power Required	50 – 300 kW

Model	Dimensions (LxWxH)	Weight
DNS-100	5500mm x 2700mm x 2000mm	10000 kg
DNS-150	5500mm x 2700mm x 1900mm	10000 kg
DNS-200	5500mm x 2700mm x 1900mm	11000 kg
DNX-100	6700mm x 2700mm x 1900mm	14000 kg
DNX-150	6700mm x 2700mm x 1900mm	14000 kg
DNX-200	5500mm x 2700mm x 2300mm	13000 kg
DVX-100	6700mm x 2700mm x 2300mm	15000 kg
DVX-150	6700mm x 2700mm x 2300mm	15000 kg
SNS-100	3400mm x 2700mm x 1900mm	7500 kg
SNS-150	3400mm x 2700mm x 1900mm	7500 kg
SNX-100	4800mm x 2700mm x 1900mm	9500 kg
SNX-150	4800mm x 2700mm x 1900mm	9500 kg
SVX-100	4800mm x 2700mm x 2300mm	10000 kg
SVX-150	4800mm x 2700mm x 2300mm	10000 kg

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- Electric drive system for simple and reliable flow control (no HPU required)
- Total system redundancy
  - 100% pump redundancy
  - 100% valve and instrumentation redundancy
  - 100% drive system redundancy (motors and VFDs)
- Up to 10-to-one turndown ratio
- Compact footprint for ease of installation and reduced space claims

High Pressure Fuel Pump System

Over 100 LNG fueled ships operate with ACD pumps, more than any other brand

- Class approvals ABS, BV, DNV, LR
- Designed for all shipboard applications
- Meets all ME-GI requirements
- MSP-GU and MSP-SL marine pumps are derived from over 40 years in Enhanced Oil Recovery applications, the most strenuous and demanding of any HP pump application
- MSP-GU and MSP-SL pumps are built in the USA and the systems are assembled in either Korea or China, depending on the customer's location and needs

Typical Scope of Supply

- High pressure pumps, gearbox or beltbox, and electric motors on a common steel skid
- Forced lubrication system for longer lifetime for pump drive operation
- All necessary valves and instrumentation for proper functionality and classification society compliance
- Variable Frequency Drives for high pressure pump motors
- Several standard options are available upon request including Control Panels, High Pressure Control Valves, and spare components

Products

Pumps – Nikkiso ACD

Model MSP-GU

Medium Flow/High Pressure Pumps for Marine Applications

Specifications

Flow Rate	1 – 10 m^3/h
Pressure	200 – 414 bar
Suction Pressure Req'd	4 bar (above saturation pressure)
Power Required	50 – 150 kW

Model	Dimensions (LxWxH)	Weight
DNS-100	4700mm x 2300mm x 2000mm	9000 kg
DNS-150	4700mm x 2300mm x 2000mm	9000 kg
DNX-100	4700mm x 2300mm x 2000mm	11000 kg
DNX-150	4700mm x 2300mm x 2000mm	11000 kg
DVX-100	4700mm x 2300mm x 2200mm	13000 kg
DVX-150	4700mm x 2300mm x 2200mm	13000 kg
SNS-100	3300mm x 2300mm x 2000mm	7000 kg
SNS-150	3300mm x 2300mm x 2000mm	7000 kg
SNX-100	3300mm x 2300mm x 2000mm	9000 kg
SNX-150	3300mm x 2300mm x 2000mm	9000 kg
SVX-100	3300mm x 2300mm x 2200mm	11000 kg
SVX-150	3300mm x 2300mm x 2200mm	11000 kg

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- Electric drive system for simple and reliable flow control (no HPU required)
- Total system redundancy
  - 100% pump redundancy
  - 100% valve and instrumentation redundancy
  - 100% drive system redundancy (motors and VFDs)
- Up to 10-to-one turndown ratio
- Compact footprint for ease of installation and reduced space claims

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Typical Scope of Supply

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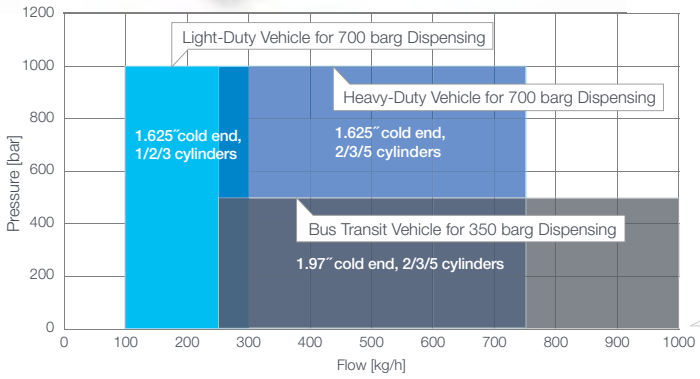
- All necessary valves and instrumentation for proper functionality and classification society compliance
- Variable Frequency Drives for high pressure pump motors
- Several standard options are available upon request including Control Panels, High Pressure Control Valves, and spare components

Products

Pumps – Nikkiso ACD

Model MP-100

Fuel Station/Storage Filling/Special Application Pump



900 bar applications require a booster pump (TC-34.2 or reciprocating booster).
500 barg applications do not require a booster.

Specifications

Bore x Stroke (single cylinder)	in	1.625 x 2.25	1.97 x 2.25
	mm	41 x 57	50 x 57
Flow Rate	gpm	2.6 – 51.5	3.8 – 75.7
	lpm	9.7 – 195.2	14.3 – 286.9
	LH_2 kg/hr	30 – 600	40 – 1,000
Pump Design Rating	hp	15 – 500	15 – 450
	kw	11 – 373	11 – 336
Maximum Discharge Pressure	psi	13,000	8,000
	bar	900	550
NPSPR	psi	5 – 15	5 – 10
	bar	0.35 – 1.0	0.35 – 0.70
Speed Range	rpm	150 – 600	150 – 600

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- Modular, compact displacement pumps available in 1, 2, 3 or 5 cylinder configurations provide a wide range of flows
- Vacuum jacketed cold end for minimal cool-down losses and economical operation, ideal for liquid hydrogen
- Pressurized oil lubricated drive with integral oil pump and reservoir, allows higher bearing loads/prevent oil leakage
- Compatible with external oil cooler or lube system for continuous duty applications
- State-of-the-art internal sealing design for high efficiency and minimized losses
- Equipment is rated for hazardous locations

Applications

- Storage filling
- Special medium to heavy-duty applications
- Continuous duty applications
- LH_2 fueling station applications
- Light-duty vehicle fueling
- Bus fueling
- HD truck fueling

Typical Scope of Supply

- Vacuum jacketed cold end with pressure oil lubricated drive end
- Vacuum jacketed suction adapter provides integrated bayonet design
- Distance piece with purge ports
- Hot dipped galvanized steel skid
- TEFC motor
- High-pressure relief valve with discharge line and surge chamber
- Drip pan kit for LH_2 applications
- Suction/vapor return manifold for multiple cylinder configurations

Products

Pumps – Nikkiso Cryo

Submerged Motor Cryogenic Pumps

Unmatched Reliability, Quality and Safety

As part of the Nikkiso Company global organization, our “original technologies” provide our customers with the confidence in knowing they are receiving the latest technology and the highest standards of engineering available.

Located in North Las Vegas, Nevada, USA, Nikkiso Cryo offers a full range of submerged pumps for LNG, LPG, LEG, LN_2, liquid propylene and many other liquefied gases.

With design, production and test facilities in both the USA and Japan, sales offices in Las Vegas, Houston, London and Tokyo, Nikkiso Cryo offers prompt and full support for all of our customers worldwide.

Specifications

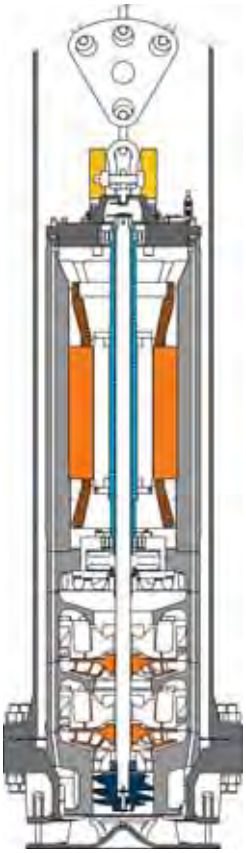
Flow Range	gpm	1 – 1,600
	lpm	4 – 6,056
	LH_2 kg/hr	15 – 25,000
NPSHR	feet	0.5 – 5
	meter	0.15 – 1.5
Differential Head	feet	50 – 4,000
	meter	15 – 1,220
Pump Design Rating	hp	3.35 – 335
	kw	2.5 – 250
Speed Range	rpm	2,000 – 10,000

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Products

Pumps – Nikkiso Cryo

Removable In-Tank Pumps



Features & Benefits

Removable, or in-tank pumps offer the advantage of overhead removal and installation without taking the tank out of service. The pump operates at the bottom of a purpose-built pump column through which it is installed and removed. The column provides the fluid discharge from the pump to the top of the tank and contains the lifting cables as well as the power cables. Our ZEN (Zero Enabled NPSH) inducer was specially developed to allow the pumps to reduce liquid levels to extremely low levels.

Applications

Liquefaction & FPSO

- Loading pump
- Recirculating pump
- Reflux pump

Regasification & FSRU

- Primary pump
- Emergency pump (FSRU)

Scope of Supply

- Pump
- Foot valve
- Lifting & electrical cables
- Headplate
- Feed through, junction box
- Vibration monitoring system

Performance Range

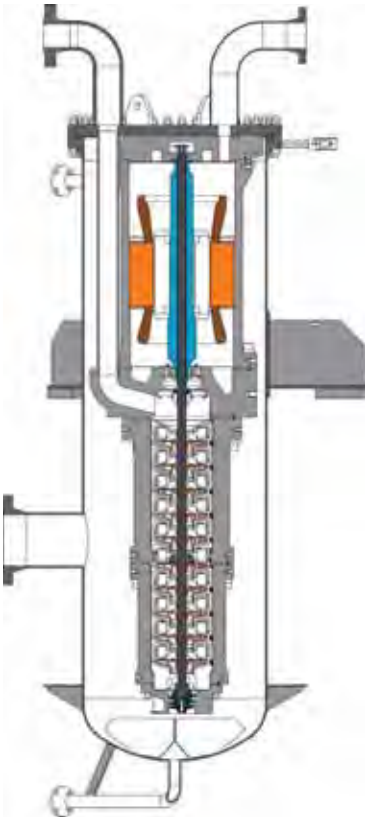
Flow: Up to 6,000 M^3/hr

Differential Head: Up to 9,000 meters

Products

Pumps – Nikkiso Cryo

Suction Vessel Mounted Pumps



Features & Benefits

This design is provided with the pump and suction vessel which becomes an integral part of the piping system with external suction and discharge connections. The pump is mounted to the top or headplate of the vessel such that the pump, motor and fluid product are totally contained within the pressure vessel. Shaft seals are eliminated. The pump inlet is below the suction vessel inlet which allows the source tank liquid levels to be lowered to a minimum.

Applications

Liquefaction & FPSO

- Transfer pump
- Booster pump

Regasification & FSRU

- Send out pump
- Line packing pump

Cogeneration

- Turbine Feed pump

Vehicle Fueling

- Fueling pump

Scope of Supply

- Pump
- Vessel & headplate
- Feed through, junction box
- Vibration monitoring system

Performance Range

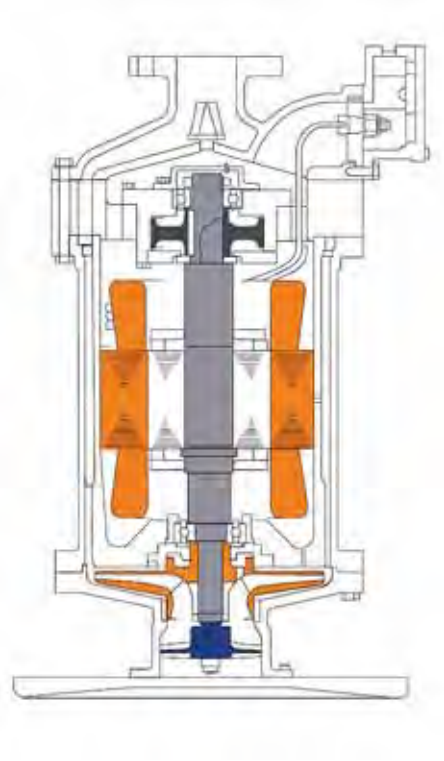
Flow: Up to 6,000 M^3/hr

Differential Head: Up to 9,000 meters

Products

Pumps – Nikkiso Cryo

Fixed In-Tank Pumps



Features & Benefits

This pump type is mounted directly to supports in the bottom of a storage tank and connected to a discharge pipe which extends to the top of the tank and out to the discharge piping. This simple and low-cost design is used in liquefied gas carriers and in any other application where removing the liquid from the tank for maintenance is a normal or required process and can be accomplished without excessive costs to the tank or system.

Applications

Liquefaction & FPSO

- Spray unloading pump (FPSO)

Regasification & FSRU

- Unloading pump (FSRU)
- Primary pump (FSRU)

Scope of Supply

- Pump
- Feed through, junction box
- Vibration monitoring system

Performance Range

Flow: Up to 6,000 M^3/hr

Differential Head: Up to 9,000 meters

Products

Vaporizers – Nikkiso Cryoquip

Marine Bunkering Solutions

Floating and Land Based Bunkering

- Pump skids
- Pressure building application for pressure transfer
- Marine class certified

Products

Vaporizers – Nikkiso Cryoquip

LNG Fuel Gas Supply Vaporizers

With the implementation of the IMO 2020 Sulphur cap reduction, the maritime industry has been transitioning their fleet's engines to dual fuel capability to utilize LNG as a cleaner option. Cryoquip has been at the forefront of this transition, providing LNG vaporization to the new fuel gas supply systems for vessels including: LNG Tankers, Container Vessels, RoRo Vessels, Ferry's, and Cruise lines.

Cryoquip's shell and tube technology has been certified by all major marine class societies including: ABS, Bureau Veritas, Class NK, DNV-GL, Lloyd's Register, RINA, and USCG. With over 6 years of operating equipment on marine vessels, Cryoquip's shell and tube VWU and water pot VWP technology are the most reliable solutions for the dual fuel marine industry.

High Pressure Vaporization for ME-GI Engines

- 415 bar(g) pressure rating
- Typical applications:
  - Carrier vessels
  - Container vessels
- Fluids:
  - LNG
  - Ethane

Low Pressure Vaporization

- Typical applications:
  - Cruise lines
  - Ferry
  - Tugboats
  - Inland waterway vessels

Products

Vaporizers – Nikkiso Cryoquip

LNG Terminals – Import

Nikkiso Cryoquip has an extensive line of LNG regasification technologies to cover many applications in both the export and import terminals. Export terminals may utilize ethylene heater, pressure builders, and flare gas vaporizers in order to operate the facility and dispose of waste streams. Nikkiso Cryoquip's ambient vaporizers have been used for these applications all over world for over 20 years.

LNG import terminals require a large capacity of regasification. For the main regasification, Nikkiso Cryoquip's portfolio of solutions including shell and tube vaporizers (STVs) and/or Ambient Air Vaporizers (AAV) are ideal for reliable operation. AAVs can also be utilized for the fuel gas heaters feeding backup submerged combustion vaporizers (SCV).

LNG Regasification Terminals

- Shell and Tube Vaporizers or Ambient Vaporizers (AAV)
- Cheniere Sabine Pass LNG
- Largest AAV's in the world
- 10,000 kg/hr

Products

Process Systems – Nikkiso Cosmodyne

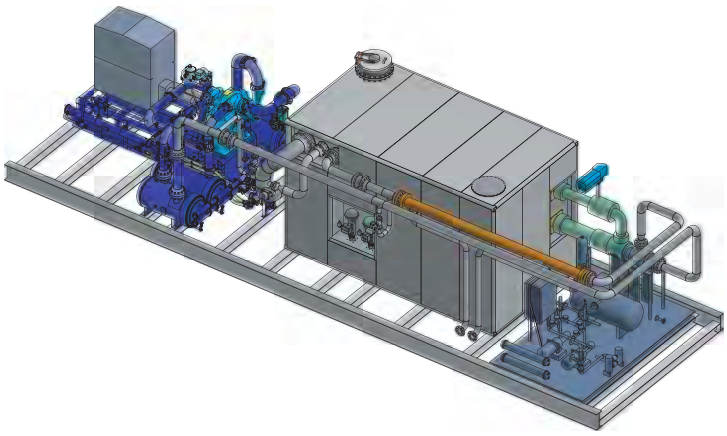
LINEX-BOG Series

Marine Class Certified BOG Subcooling and Reliquefaction Systems

Nikkiso Cosmodyne's LINEX-BOG subcooling and reliquefaction system provides tank pressure management by subcooling LNG or by reliquefying excess boil-off gas. The system utilizes robust, industry standard components that can be customized to a client's specific ship requirements. Our typical size packages range from 250 kg/h to 3,300 kg/h.

Nikkiso Cosmodyne's BOG subcooling and reliquefaction system builds on over 60 years of cryogenic experience, with over 450 installations worldwide. Our experience includes air separation and natural gas liquefaction facilities and plants built to operate on aircraft carriers.

Nikkiso Cosmodyne is part of the Nikkiso group of companies already providing cryogenic equipment to the marine LNG fueling and cargo industry.



Experience

Nikkiso companies have several hundred years of combined experience in engineering highly complicated cryogenic systems for off-shore and on-shore applications.

Our skids are built in our wholly-owned marine certified fabrication centers including centers in the United States and South Korea.

Benefits & Features

- Automatic load & unload included in controls to maintain tank pressure
- Local & remote push button start/stop
- Robust industry standard machinery

Cosmodyne Competence for LNG Supply Chain

	Dual Fuel Vessels (DF)	LNG Gas Carrier (LNGGC)	FSRU	LPGC, Ammonia, Hydrogen, e-Fuels, MCH
FGSS with Recondenser and Subcooler	●	●	●	●
BOG Reliquefaction Systems	●	●	●	●
Submerged Cryogenic Pumps	●	●	●	
Cryogenic Heat Exchangers	●	●	●	●
Regasification Systems			●	
Recondensers / Subcoolers			●	
BOG Compressors	●	●	●	
Controls Package	●	●	●	●
Maintenance Package	●	●	●	●

One Nikkiso company to handle all of the above requirements with a single point guarantee!

Products

Process Systems – Nikkiso Cosmodyne

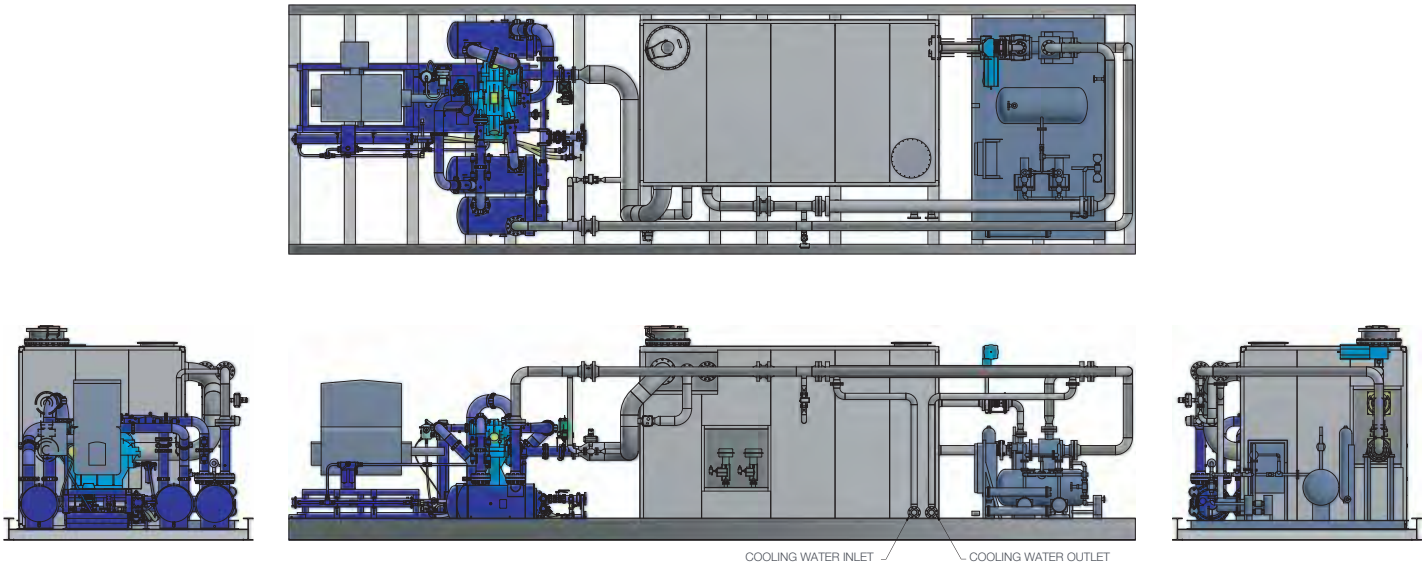
LINEX-BOG Series

Performance Specifications

		LINEX-BOG			
Model		8	14	25	35
Expected Performance					
Subcooling Capacity (max)	TPH	0.7	1.4	2.5	3.5
Total Electric Power (excluding cooling water)	kW	675	1168	2174	2870
Expected Flows					
LNG Subcooling Flow	m^3/hr	24	45	81	112
Min. Subcooling Temp.	K	96	96	96	96
Cooling Water Flow	m^3/hr	107	185	340	455

NOTES:

1. Cooling water temperature: 36 °C
2. BOG latent heat: 465 kJ/kg

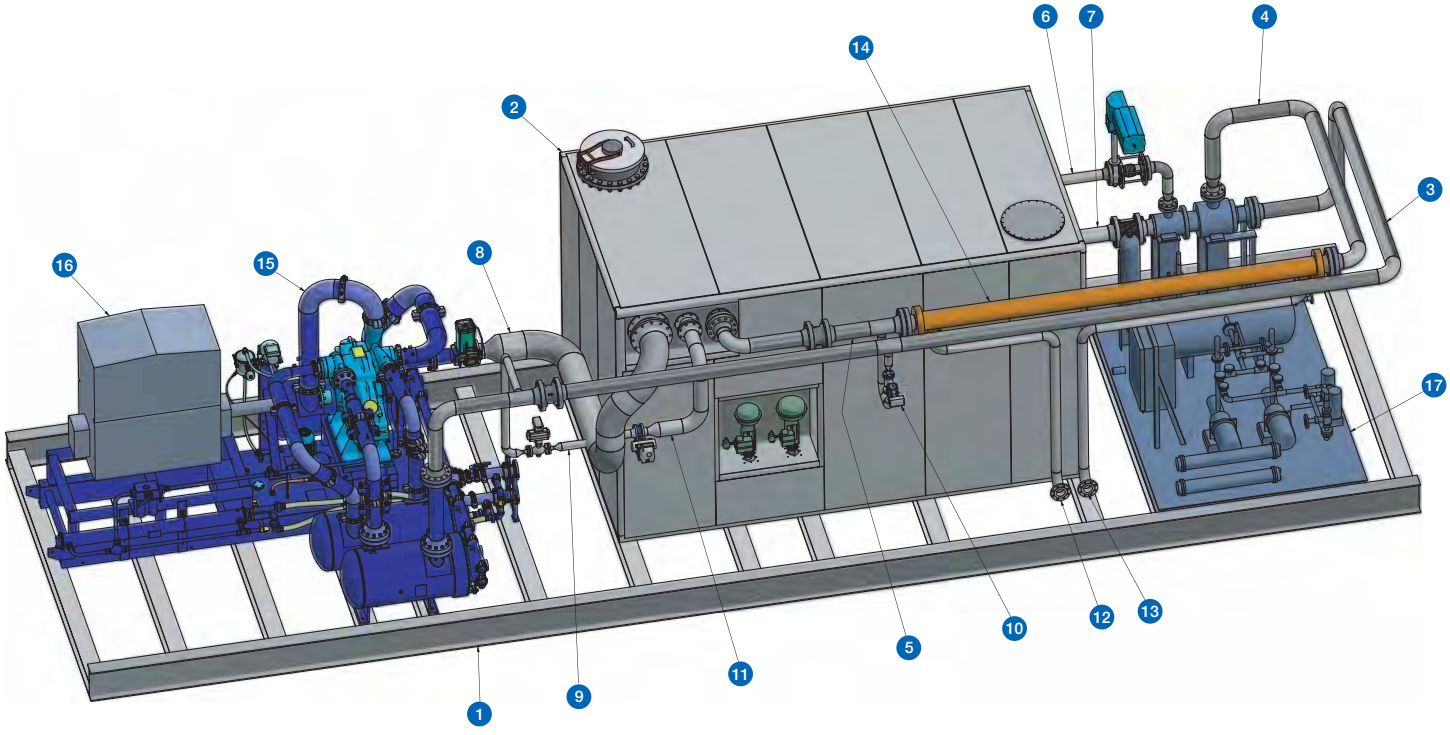


Products

Process Systems – Nikkiso Cosmodyne

LINEX-BOG Series

1. Frame
2. Cold box module
3. Compressor discharge
4. Booster discharge
5. Booster aftercooler outlet
6. Turboexpander inlet
7. Turboexpander outlet
8. Compressor suction
9. Compressor bypass
10. Booster bypass
11. Gan from separator to recycle
12. Cooling water inlet
13. Cooling water outlet
14. Booster aftercooler
15. Recycle compressor
16. Recycle compressor motor
17. Turboexpander skid



Products

Process Systems – Nikkiso Cosmodyne

LINEX-BOG Series

Standards

Nikkiso Cosmodyne's Linex-BOG subcooling and reliquefaction system is designed to meet all major maritime class society requirements. At minimum, design is in compliance with the following codes:

- IGC and IGF;
- ASME's Boiler and Pressure Vessel;
- DNV Pt.5 Ch.7 "Liquefied Gas Tankers" – DNV Maritime Code;
- DNV Pt.4 Ch.6 "Piping Systems" – DNV Maritime Code;
- ABS Part 3 Hull Construction and Equipment;
- ABS Part 4 Vessel Systems and Machinery.

DNV

APPROVAL IN PRINCIPLE

Particulars of Product

Designer: **NIKKISO COSMODYNE**

Product: **Boil-Off-Gas Handling Plant for LNG**

This is to verify:

That the design and arrangement of proposed system for pressure and temperature control in cargo tanks of LNG carriers will comply with respect to applicable rules and regulations and is capable to meet goals stated in IGC Code Chapter 7 and can be used onboard of vessels and installations classed by DNV.

Basis for Approval

The documentation submitted for approval specified in approval letter Ref. M-SA-E/ILCHEN/P35297-J-9 "Nikkiso Cosmodyne LLC Gas Carrier Excellence Center, ID P35297, Re-Nikkiso Cosmodyne - Boil-off-Gas System", dated 2021-10-26, which has been assessed with respect to applicable paragraphs of following Rules and Regulations:

- DNV Rules Pt.5 Ch.7 "Liquefied Gas Tankers" July 2021 editions
- DNV Rules Pt.4 Ch.6 "Piping systems" July 2021 edition
- 2016 IGC Code (Resolution MSC.370(93)) as amended off July 2021

Conditions and Assumptions for Approval

The AIP (approval in Principle) has been issued with conditions and assumption given in Class letter for ID P35297 "AiP (Approval in Principle) Boil-Off-Gas handling System from Nikkiso Cosmodyne", dated 2021-10-27.

Place: **Høvik, Norway)** Date: **2021-10-27**

for **DNV**

Monika

Head of Department

LEGAL DISCLAIMER: Unless otherwise stated in the applicable contract with the holder of this document, or following from mandatory law, the liability of DNV AS, its parent companies and their subsidiaries as well as their officers, directors and employees ("DNV") arising from or in connection with the services rendered for the purpose of the issuance of this document or reliance thereon, whether in contract or in tort (including negligence), shall be limited to direct losses and under any

the vessel.

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Additionally:

- All major equipment sourced from marine class approved providers with marine class approved designs;
- Fabrication completed in Nikkiso's own marine class approved shops or 3rd party fabricators in the US and South Korea (e.g., welding, weld nondestructive examination, testing);
- Eliminating additional testing of cryogenic metallic material;
- Full material traceability in accordance with ISO/EN 10204 3.1 and ISO/EN 10204 3.2 material certificate standards;
- Independent FMEA report, etc.;
- All electrical equipment is at minimum in accordance with maritime recognized IECEx Zone 2 requirements (identical to Class 1 Division 2 requirements).

Our Approval-in-Principle Certifications from DNV Maritime and ABS confirm Cosmodyne's design compliance to the above listed rules.

Quality Policy

In accordance with its Vision, Mission and Quality Policy, Nikkiso Clean Energy & Industrial Gases is committed to a continuous improvement of Customer satisfaction by focusing its entire organization on Safety of systems and products, Customer Service, Operational Excellence, Technology Leadership and Quality.

Services

Marine Services

Marine service team is committed to maintain and service low pressure and high pressure fuel pumping systems. Our expertise extends past repairs and parts to include control systems, seal gas systems and lube oil upgrades.

Marine Services include:

- Commissioning
- Gas and sea trials
- Onshore/offshore field service support
- Long Term Service Agreements
- Operation training

Gas and Sea Trials include:

- Equipment integrity check
- Connection and routing verification
- Lube Oil (LO) system verification
- System and control feedback verification
- VFD or HPU parameter and program verification
- Control unit check
- Performance analysis
- On-site troubleshooting

Services

Service Agreement

Service Agreement Benefits

- Professionals will identify and solve any existing problems with your system before they escalate and become costly
- A fixed-rate service plan provides a dependable Opex for budgetary purposes
- The burden of system reliability falls on us, the service provider. Less human capital required by end user
- Well-maintained, more efficient systems have less down time, limits product losses and reduces the risk of topping gas operations
- Guaranteed 24/7 support with 24-hour response time to service requests
  *Extended scope of service available upon request

Service Agreement Structure

- Fixed annual price of spare parts
- Covered repair packages
- Periodic site evaluation with report
- Pre-scheduled preventative maintenance
- Continuous improvement projects
- Spares and inventory management
- Exchange programs
- Design improvement projects
- Single service point for all needs
- System remote monitoring

LTSA Packages

	1 Year	3 Year	5 Year
Commissioning spare kit	●	●	●
Capital spare kit	●	●	●
Standard consumable goods	●	●	●
Unlimited CE repair	●	●	●
1-week on-site support	●	●	●
2-week commissioning/trials on-site support (new vessels)	●	●	●
Critical inventory management	–	●	●
Yearly on-site preemptive Inspection	–	●	●
Drive overhaul inspection	–	●	●
Critical inventory exchange program	–	●	●

NIKKISO

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